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**Datasheet for the decision
of 28 September 2017**

Case Number: T 1348/12 - 3.4.03

Application Number: 02789218.1

Publication Number: 1451853

IPC: H01L21/00, H01L29/06,
H01L27/15, H01L33/00

Language of the proceedings: EN

Title of invention:

DIODE HAVING VERTICAL STRUCTURE AND METHOD OF MANUFACTURING
THE SAME

Applicant:

LG Innotek Co., Ltd.

Headword:

Relevant legal provisions:

EPC 1973 Art. 56
EPC Art. 123(2)

Keyword:

Inventive step - Main and First Auxiliary request - (no)
Amendments - extension beyond the content of the application
as filed - Second Auxiliary request - (yes)

Decisions cited:

Catchword:



Beschwerdekammern
Boards of Appeal
Chambres de recours

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Case Number: T 1348/12 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 28 September 2017

Appellant: LG Innotek Co., Ltd.
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Representative: Cabinet Plasseraud
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted on 28 December
2011 refusing European patent application No.
02789218.1 pursuant to Article 97(2) EPC.

Composition of the Board:

Chairman G. Eliasson
Members: M. Papastefanou
T. Bokor

Summary of Facts and Submissions

- I. The appeal is against the decision of the Examining Division refusing the European patent application No. 02 789 218.1 (published as WO 03/038874 A1) on the grounds that claim 1 of the Main request as well as of the First and Second Auxiliary requests before it did not involve an inventive step within the meaning of Article 56 EPC and that claim 1 of the First and Second Auxiliary requests did not comply with the requirements of Article 123(2) EPC. With the statement of grounds of appeal, the Appellant (Applicant) submitted claims of a Main request, as well as of a First and a Second Auxiliary requests.
- II. From the documents cited by the Examining Division, the following are relevant for this decision:
D5: DE 200 09 283 U1
D6: JP 2 290084 A
- Reference is also made to the automatic English translation of D6, which will be referred to as D6a.
- III. In a communication pursuant to Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA) the Board communicated its preliminary, non-binding opinion that claim 1 of the Main and First Auxiliary requests did not appear to involve an inventive step in view of an obvious combination of D5 and D6. Claim 1 of the Second Auxiliary request did not appear to be new over D5. In addition, objections under Article 123(2) EPC were raised against claim 1 of the First and Second Auxiliary requests.
- IV. With a letter dated 25 August 2017 the Appellant filed amended claims for the Main and First Auxiliary

requests as well as an amended description and argued against the objections raised by the Board.

V. At the end of the oral proceedings held before the Board, the Appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims of the Main request filed with the letter dated 25 August 2017, or, as an auxiliary measure, of the First Auxiliary request, filed also with the same letter, or of the Second Auxiliary request, filed with the grounds of Appeal.

VI. Claim 1 of the **Main request** reads as follows:

A light emitting diode comprising:

a first pad;

a first electrode (500) on the first pad, the first electrode being conductive;

a first-type GaN layer (140) on the first electrode;

an active layer (160) on the first-type GaN layer;

a second-type GaN layer (180) on the active layer;

a second electrode (240) on the second-type GaN layer;

and

a second pad (260) on the second electrode,

wherein the first electrode serves to reflect light emitted from the active layer, wherein the first pad is located at the bottom of the diode, wherein the first and second pads are made of Au, wherein the second pad has a thickness of 0.5 μm or higher, wherein the second pad contacts the second electrode that is electrically connected to the second-type GaN layer and wherein a width of the first electrode, that is an electrical contact to the first-type GaN layer, is greater than a width of the second pad.

VII. Claim 1 of the **First Auxiliary request** reads as follows:

A light emitting diode comprising:

a first pad;

a first electrode (500) on the first pad, the first electrode being conductive;

a first-type GaN layer (140) on the first electrode;

an active layer (160) on the first-type GaN layer;

a second-type GaN layer (180) on the active layer;

a second electrode (240) on the second-type GaN layer;

and

a second pad (260) on the second electrode,

wherein the first electrode serves to reflect light emitted from the active layer, wherein the first pad is located at the bottom of the diode, wherein the first and second pads are made of Au, wherein the second pad has a thickness of more than 0.5 μm , wherein the first-type GaN layer is electrically connected to the first pad via the first electrode, the second-type GaN layer is electrically connected to the second pad via the second electrode, and wherein a width of the first electrode is greater than a width of the second pad.

VIII. Claim 1 of the Second Auxiliary request reads as follows:

A light emitting diode comprising:

a first electrode (500);

a buffer layer (105, 120) and a p-GaN layer (180) on the first electrode;

an active layer (160) between the buffer layer and the p-GaN layer; and

a second electrode (240) contacting the p-GaN layer; wherein the first electrode covers the buffer layer and

is a reflective layer configured to reflect light from the active layer.

Reasons for the Decision

1. The appeal is admissible.
2. The claimed invention

The application relates to GaN-based light emitting diodes (LEDs) having a vertical structure (see Figure 2). The LED comprises a first-type (n) GaN layer (140) and a second-type (p) GaN layer (180) with an active layer (160) between them. Under the first-type GaN layer there is a (first) electrode (500) and on top of the second-type GaN layer there is a (second) electrode (240). The first electrode (500) reflects the light emitted from the active layer so that most of the light is emitted through the top side (as seen in Figure 2) of the LED. On both electrodes there are metallic pads (500 and 260 in Figure 8) which are made of Au and have a thickness of at least 0.5 μm (see paragraphs [0026], [0027] and [0035] of the published application).

3. The closest prior art
- 3.1 The Examining Division regarded document D5 as the closest prior art. The Appellant did not contest this and the Board does not see any reason to differ.

D5 discloses a LED having a vertical structure (see Figure 1). The LED comprises several semiconductor layers (1) made of GaN (page 6, lines 34-36). Between these semiconductor layers there is an active layer (2) which generates the emitted light (page 7, lines 1-3). There is no explicit disclosure of p- and n-type GaN

layers in D5, only of *different* semiconductor layers (page 6, line 36); it is, however, implicit that for the LED to function, the active layer must be placed between p-type and n-type semiconductor layers. There is a metallic surface (4) (at the bottom of the LED as seen in Figure 1), which is directly formed on the semiconductor layer and which functions as reflector (6) for the light emitted from the active layer (page 7, lines 5-11). This causes most of the generated light to be emitted from the top of the LED (as seen in Figure 1). This metallic surface serves also as a contact (first electrode), while on the other side of the LED (i. e. top side) there is a second contact (electrode - 12) which is directly formed on the semiconductor layer (page 7, lines 11-13). There is no disclosure of pads in the LED of D5.

4. Main request

4.1 Compared to the LED in D5, the LED defined in claim 1 of the Main request comprises the additional features relating to the first and second pads, i. e. that there is a first pad on which the first electrode lies, that there is a second pad on the second electrode, that the pads are made of Au, that the second pad has a thickness of 0,5 μm or higher, that the second pad contacts the second electrode and that the width of the first electrode is greater than a width of the second pad.

4.2 These differentiating features provide the technical effect of allowing electrical connection and flow of electrical current through the LED, while at the same time ensuring mechanical stability of the electrical connection. The technical problem for the skilled

person starting from D5 would thus be, how to modify the LED of D5 in order to obtain this technical effect.

4.3 In D5, it is indicated that the bottom part (metallic surface 4 - see Figure 1) of the LED should be put on a metallic piece (body - *Metallkörper*) which would function both as a carrier (*Träger*) as well as electrical contact (page 7, lines 13-17).

4.4 Document D6 describes a LED having also a vertical structure and shows (Figure 2(d)) the use of metallic pads (bonding electrodes 6) on the electrodes (ohmic contacts 4 and 5; see also pages 6 and 8 of D6a) which are formed on either side of the LED.

4.5 The skilled person starting from D5 and trying to solve the identified technical problem, would find the obvious solution to add pads on the electrodes of the LED, as already hinted in D5 and indicated in D6. As described in D6, the pads are made of the same material (Au) and have the same thickness ($5000\text{\AA} = 0.5\ \mu\text{m}$) as the ones in the claim (see page 8 D6a). It is considered self-evident that the second pad (i. e. the one on the top in Figure 1 of D5) would contact the second electrode. From Figure 1 of D5, it becomes also evident that the width of the first electrode (4) would be greater than the width of the second pad (which would be on the second electrode/contact (12)).

Hence, the subject matter of claim 1 of the Main request is obvious to the skilled person taking the combination of D5 and D6 into account.

4.6 The Appellant argued that the technical problem should not be formulated so broadly. LEDs made of GaN were a specific type of diodes with specific technology and

corresponding problems. Therefore, the problem should be reformulated as how to allow electrical connection and flow of electrical current through a GaN-based LED, while at the same time ensuring mechanical stability. Faced with this technical problem, the skilled person starting from D5 (which also describes GaN-based LEDs) would never look into D6 for a solution because the LED in D6 comprised semiconductor layers made of SiC (see D6, abstract), which is a different material, with different properties and associated issues.

Even if the skilled person were to consider D6, the combination of the teachings of D5 and D6 would still not disclose the feature of the second pad contacting the second electrode that is electrically connected to the second-type GaN layer because in D6 the corresponding electrode was contacting a SiC layer and not a GaN layer.

- 4.6.1 The Board cannot follow the Appellant's argument. The use of pads on the electrodes of the LED is unrelated to the semiconductor material used. The pads are not connected to the semiconductor layers directly but to the electrodes (metallic contacts). Even if it were considered that GaN-based semiconductors are different from SiC-based semiconductors, this would be irrelevant to the use of the pads since the pads address a technical problem which is common in both types of LEDs: to allow electrical connection and flow of electrical current through the LED and to ensure mechanical stability of the electrical connection. Hence, the Board remains with the definition of the technical problem to be solved as it is formulated in paragraph 4.2 above.

In addition, since the contacts (electrodes) contacting the GaN layer are already part of the LED in D5, the skilled person would need only to take the pads from the LED of D6 and not any of the remaining layers. Hence, the combination of the two teachings will yield a LED with the features of claim 1.

4.7 The conclusion is that the subject matter of claim 1 of the Main request does not involve an inventive step within the meaning of Article 56 EPC 1973.

5. First Auxiliary Request

Claim 1 of the First Auxiliary request differs from Claim 1 of the Main request only in wording. As the Appellant also confirmed during the oral proceedings, the subject matter of the two claims is the same.

Consequently, Claim 1 of the First Auxiliary request does not involve an inventive step within the meaning of Article 56 EPC 1973 for the same reasons as for the Main request.

6. Second Auxiliary request

6.1 Claim 1 of the Second auxiliary request defines a light emitting diode with only one GaN layer, which is a p-GaN layer.

In the originally filed application, however, there is no embodiment of a LED without both a n-GaN (first-type) layer and a p-GaN (second-type) layer. Neither is there any indication that would lead the skilled person to derive such an embodiment in a direct and unambiguous manner.

6.2 Hence, the omission of the n-type GaN layer in the definition of the LED in claim 1 amounts to an intermediate generalisation, which has no basis in the originally filed application. The Appellant did not provide any comments on this objection by the Board, neither in writing nor during the oral proceedings.

6.3 The conclusion is, therefore, that claim 1 of the Second Auxiliary request does not meet the requirements of Article 123(2) EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

G. Eliasson

Decision electronically authenticated